THREE-D GEOCONSULTANTS LIMITED

Open File Report 90-12

REFRACTORY GOLD

IN

NEW BRUNSWICK

by

Three-D GeoConsultants Ltd.
with Thibault and Associates Inc.

Canada-New Brunswick Mineral Development Agreement

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Hon. Morris Green
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Hon. Edmond P. Blanchard
Minister of State for Mines

December, 1990

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NEW BRUNSWICK

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22 June 1990

New Brunswick Department of
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Mineral Development Branch
P.O. Box 6000
Fredericton, N.B.
E3B 5H1

Attention: R.D. Harris
Project Engineer

Dear Mr. Harris:

RE: Refractory Gold in New Brunswick
Report 8923-1

We are pleased to submit the final edition of this report. This submission consists of one unbound original, three bound copies and one copy on diskette (WordPerfect 5.1).

Yours truly,
THREE-D GEOCONSULTANTS LIMITED

F.D. Ball
President

EXECUTIVE SUMMARY

Several of the gold properties currently being evaluated in the Province of New Brunswick are refractory in nature. Pretreatment of the concentrate is required to convert the matrix into a relatively porous oxide form amenable to conventional cyanidization techniques for recovery of the gold. The concept of a central processing facility or custom mill for the recovery of gold from New Brunswick's refractory ores offers economies of scale. The capital investment would be shared among several developers through user pay charges and the availability of the central mill would encourage development of small, normally uneconomic deposits. Previous work (Whalen and Thibault, 1989) had identified that a major concern with the custom mill concept was the availability, composition and variability of feedstock. It had been recommended that prior to conducting further piloting tests on any technology, the availability and variability of refractory gold deposits in New Brunswick should be evaluated. This study was undertaken in response to those recommendations.

During the last five years, processing studies on refractory gold occurrences in Northern New Brunswick have categorized the ore types as arsenopyrite-pyritic ores. The availability of these types of refractory ores was emphasized as an indigenous feedstock for the custom mill concept. It was this category of refractory gold property that was targeted by this study. In addition, several gold bearing base metal deposits currently being mined are also known to contain refractory gold. Of the 201 gold occurrences, prospects and deposits compiled in a primary list, 25 properties were identified for further study and evaluation. Six of these properties were subsequently short listed as exhibiting some promise of being able to supply refractory gold ore to a custom mill. The 6 properties short listed include Murray Brook, Simpson Field, Caribou, Elmtree, Millstream West, and Middle River Gold.

Four of the short listed properties, Elmtree, Millstream West, Simpson Field, and Middle River are, in terms of their economic potential, monomineralic gold properties. Elmtree is the only one of the four which can be characterized as a gold deposit in that it is the only one containing quantifiable reserves. The Elmtree deposit contains between 500,000 and 750,000 tonnes of indicated geological reserves grading 4.38 g/tonne gold. The remaining two properties, Caribou and Murray Brook are massive sulphide deposits bearing gold.

Based on the status of mineral exploration and the known ore reserves, the custom mill concept is best suited for processing gold and silver-bearing tailings from the Caribou deposit. Ongoing assessment of developments at the other refractory gold-bearing properties identified in the province could lead to supplementary feedstock for the custom mill.

Delineation of the various refractory gold-bearing properties must be advanced to a stage where quantification of reserves would permit evaluation of their ability to supply ore to a refractory gold processing facility. In addition, laboratory assessment of the refractory nature of the ores from the various properties identified is required. This assessment should include bench scale cyanidation tests.

Evaluation of the technical and economic feasibility of extracting the refractory gold which may be contained in the inventory of mine tailings found in the Bathurst mining camp is warranted. This inventory of mine tailings is spread amongst several past and current producers of base metals in the camp. The economics of such a venture could be enhanced by the extraction of additional by-products from the tailings which could also mitigate environmental difficulties currently encountered with tailings disposal.

SOMMAIRE EXÉCUTIF

Plusieurs propriétés d'or au Nouveau-Brunswick récemment évaluées démontrent qu'elles sont réfractaires en nature. Afin de récupérer l'or, en contradiction avec la méthode technique conventionnelle de cyanurisation, un traitement du concentré est nécessaire pour convertir les matrices en une forme d'oxyde relativement poreuse. Le concept d'une facilité centrale de traitement ou d'un moulin spécialisé pour l'extraction de l'or des minerais réfractaires du Nouveau-Brunswick offrirait une forte économie. Le capital investi serait partagé parmi plusieurs dévelopeurs ou les usagers du moulin payeront les frais. La disponibilité d'un moulin central encouragerait le développement de dépôts minimes qui est normalement non-économique. Des projets entrepris (Whalen et Thibault, 1989) ont démontrés que les facteurs majeurs concernant le concept de la fabrication d'un moulin spécialisé serait la disponibilité, composition ainsi que la variabilité du minerai brute. Il a été donc recommandé d'évaluer la disponibilité et la variabilité de dépôts d'or réfractaires au Nouveau-Brunswick avant de continuer n'importe quel test pilote technologique. Cette étude a été entreprise en fonction des recommandations mentionnées ci-dessus.

Pendant les cinq dernières années, des études ont démontré que la catégorie type de minérais dans le nord du Nouveau-Brunswick est arsonopyrite-pyritique. La disponibilité de cette catégorie type de minérais réfractaires brute est en grande partie indigène pour le concept d'un moulin spécialisé ou central de traitement. Ce genre d'or réfractaire a été choisi pour la réalisation de cette étude. De plus, il est reconnu que des dépôts de métaux de base contenant de l'or présentement en extraction contient de l'or réfractaire. Il y a eu 25 propriétés choisis (événements, prospection, dépôts) et identifiés pour de futures sites d'étude et évaluation, sur 201 dépôts compilés de la liste primaire. Six de ces propriétés démontrent un potentiel pour répondre aux besoins d'or réfractaire afin de pouvoir fournir un moulin spécialisé.

Les six propriétés finales choisies de la liste pour fin d'étude sont les suivantes : Murray Brook, Simpson Field, Caribou, Elmtree, Millstream West, Middle River.

Quatre de six propriétés choisies soient, Elmtree, Millstraeam West, Simpson Field et Middle River contiennent de l'or monomineral qui leur donnent une caractéristique économique importante. Elmtree est la seule propriété caractérisée par un dépôt d'or contenant des réserves connues. Ces réserves contiennent entre 500,000 et 750,000 tonnes et indiquent une réserve géologique classée á 4.3 g/tonne d'or. Les deux autres propriétés, soient Murray Brook et Caribou contiennent des dépôts massifs de sulfure contenant de l'or.

Fondé sur le status de l'exploration mineral et la quantité connue des minérais, le moulin specialisé serait mieux utilisé pour le traitement de minérais contenant de l'or et de l'argent provenant des dépôts de la mine Caribou. D'autres évaluations sont en cours afin de développer d'autres minérais réfractaires contenant de l'or. Ces propriétés identifiées par les évaluations dans la province pourraient augmenter la qantité de minérais brutes pour le moulin spécialisé.

La délinéation d'une variétée de proptiétés de minérais réfractaires d'or doit être à un stage où on doit connaitre les quantités connues des réserves afin dévaluer leur capacité de fournir le moulin spécialisé. En plus, une évaluation en laboratoire de l'or réfractaire en nature dans les minérais des propriétés identifiées sont requises. Ces évaluations devraient inclure des tests "bench scale" de cyanures.

Les propriétés minières dans les environs de Bathurst contiennent aussi de l'or réfractaire dans leurs produits minérais après l'extraction des métaux principaux.

Une évaluation économique et méthode technique seraient recommandées avant d'entreprendre l'extraction de l'or. Ces minérais son répendus dans les régions environnantes des propriétés récentes, abandonnées ou anciens producteurs de métaux de base. L'économie pourrait être avantagée par l'extraction de d'autres produits additionnels et pourrait aussi atténuer les difficultés environnmental courraments rencontrées par ces dépôts qui sont disposés sans d'autres alternatives.

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1.0 INTRODUCTION

Several of the gold properties currently being evaluated in the Province of New Brunswick are refractory in nature. The gold is finely disseminated within a complex sulphide matrix which results in capital intensive processing. Pretreatment of the concentrate is required to convert the matrix into a relatively porous oxide form amenable to conventional cyanidization techniques for recovery of the gold.

The concept of a central processing facility or custom mill for the recovery of gold from New Brunswick's refractory ores offers economies of scale. The capital investment would be shared among several developers through user pay charges and the availability of the central mill would encourage development of small, normally uneconomic deposits.

Previous work (Whalen and Thibault, 1989) had identified that a major concern with the custom mill concept was the availability, composition and variability of feedstock. It had been recommended that prior to conducting further piloting tests on any technology, the availability and variability of refractory gold deposits in New Brunswick should be evaluated. This study was undertaken in response to those recommendations.

The gold deposits of New Brunswick fall into five categories (Boyle, 1979):

1. Gold-quartz deposits in metasedimentary and metavolcanic rocks of Precambrian and Palaeozoic age.
2. Auriferous polymetallic deposits
3. Auriferous massive sulphides
4. Lithified placers
5. Non-lithified placers

While all types occur in New Brunswick, the first three are most prevalent. The gold-quartz deposits (1) usually bear gold in its free state. The polymetallic and massive sulphide deposits (2 & 3)

can contain gold, both in its free state and/or locked within sulphides. The latter are referred to as being refractory, in that gold cannot be extracted utilizing conventional cyanidation techniques.

Refractory gold ores are categorized based on chemical and metallurgical factors which are responsible for the inefficiency of conventional cyanidation and not from a geochemical point of view. The various types of refractory gold ores have been reviewed by Henley (1975) and Litz (1988). Refractory gold ores, in relation to gold recovery processes, are generally categorized as follows:

1. Arsenopyrite/Pyrite:
   -oxidation by chemical or thermal means has been a standard treatment before cyanidation for such ores;
   -arsenopyrite - 0.2 to 2% sulfide sulfur and up to 1.5% As;
   -pyrite - 4.8% sulfide, less than 0.17% arsenic;
   -direct cyanidation usually shows less than 40% dissolution of gold after very fine grinding of ore.
2. Sulfosalt:
   -usually contain high silver which is smelted to recover precious metals;
   -contain up to 3% sulfide sulfur and significant sulfosalts complexed with arsenic, antimony, lead, copper and zinc, which encapsulate the gold;
   -little or no gold is associated with pyrite.
3. Carbonaceous/Mixed Carbonaceous:
   -ores are generally alkaline, contain carbonaceous material and can be classes as "coaly" or "graphitic";
   -some ores may contain up to 45% limestone or dolomite;
   -gold is contained in carbon and the carbon is generally oxidized by roasting or pressure leaching before cyanidation.
4. Tellurides:
   -gold is chemically bound with tellurium or combination of silver, lead, antimony, iron, copper and bismuth;
   -gold is commonly recovered as a by-product during smelting of concentrates;
   -processing of gold-silver tellurides by cyanidation requires extended extraction times, without prior oxidation.
5. Uranium:
   -native gold is enclosed in uranium minerals - acid treatment is required prior to cyanidation.

During the last five years, processing studies on refractory gold occurrences in Northern New Brunswick have categorized the ore types as arsenopyrite-pyritic ores. Technologies available to treat these ore types were reviewed by P.J. Whalen and J.D. Thibault (1988). Preliminary bench scale studies were also used to determine order of magnitude capital and operating costs for a custom mill. Therefore, the availability of auriferous arsenopyrite-pyritic type refractory ores was emphasized as an indigenous feedstock for the custom mill concept. It was this category of refractory gold property that was targeted by this study.

The refractory gold deposits in New Brunswick have until recently been largely overlooked due in part to their characteristically low grade. Generally the emphasis on mineral exploration in the province has been placed on base metals rather than gold. The discovery of the Elmtree deposit by Lacana (now owned by Corona) and gold production from Gordex's Cape Spencer deposit have altered this situation. The Elmtree is host to refractory gold as are other prospects currently being explored. In addition, several gold bearing base metal deposits currently being mined are also known to contain refractory gold.

1.1 Project Objective

The objective of this study was to determine the mineralogical variability and the resource potential of refractory gold deposits in New Brunswick.

1.2 Study Approach

To accomplish the objective of the study the following approach was adopted:

1. Search the New Brunswick Department of Natural Resources and Energy's Mineral Occurrence File for gold bearing mineral occurrences.
2. Prepare a primary list of gold occurrences through the

selection of promising occurrences, prospects and deposits based on their reported size, grade and/or apparent promising outlook for development based on past and/or current exploration activities.

3. Examine all current information relative to the primary list available in the mineral assessment files of the New Brunswick Department of Natural Resources and Energy.
4. Reduce the primary list to one bearing only those prospects and deposits which contain refractory gold.
5. Further refine the data base for the remaining listed prospects and deposits, in terms of quantity, mineralogy and grade through literature sources and personal interviews with informed individuals.

2.0 DATA ASSEMBLY AND SYNTHESIS

2.1 Listing of Occurrences

Compilation of a primary list of gold occurrences was accomplished by reviewing all gold occurrences listed in the New Brunswick Department of Natural Resources and Energy, Mineral Occurrence File. The list contains 201 gold occurrences, prospects and deposits. Of these, 173 had reported assays in excess of 0.5 g/tonne. An additional 28, having lower assays, had received at least marginally more exploration attention thus permitting more informed assessment of their potential. The majority of the listings, however, are occurrences with little more information reported than a few grab samples and/or assays.

Reduction of the Mineral Occurrence list through selection of only those properties applicable to this study was accomplished by the application of the following criteria:

1. Deposits with reported tonnages and grade for gold.
2. Gold prospects or occurrences with a sufficient data base to permit at least gross classification according to geologic type and mineralogic association.

A total of 25 deposits, prospects and occurrences, collectively referred to as properties, were identified for further study and are included on the primary list (Table 2.1.1). The listed reserves and grades were derived from the Mineral Occurrence File.

2.2 Property Evaluation

The objective of this phase of the study was three-fold:

1. To update and, where necessary, augment the data provided in the Mineral Occurrence File for each property.
2. To shorten the list further if recent exploration had failed to confirm or enhance a property's potential for production.
3. To identify any deficiencies or adversities in the selected properties which would be detrimental to the custom mill concept.

Table 2.1.1 Primary list of properties slated for detailed evaluation

Property	Mineral Occurrence File #	Reserve (1000's tonnes)	Cu (%)	Pb (%)	Zn (%)	Au (g/tonne)	Ag (g/tonne)	Comments
Cape Spencer	35	550.5 proven	--	-	--	2.5	--	1.5 yrs. of production have reduced reserves
		226.3 possible	--	--	--	2.26	--	
Lumsden	056	--	0.24	--	0.64	6.51	8.57	Channel sample, 8.7m
Orvan Brook	062	136.1	0.20	3.27	2.13	0.58	86.4	
Lavigne Brook	070	--	0.45	--	--	1.71	161.14	Trench sample, 3.1m
Bradley Brook(Zarina)	080	--	--	--	--	4.97	308.57	Bulk sample, 7-30cm vein
Madran	121	--	--	--	--	8.02	--	Trench sample, 3.0m
Restigouche	139	2095.0	0.34	5.61	7.05	1.47	127.2	
Duvicourt Deposit	147	136.1	0.42	1.23	1.00	0.96	90.86	
Captain	159	311.2	1.99	--	--	0.58	9.60	
Canoe Landing Lake	242	20,380.0	0.56	0.64	1.82	1.07	29.5	
Nerepis Gold	334	--	--	--	--	2.33	--	Trench sample, 6.7m
Heath Steele	395	4,700.0	1.00	1.31	5.34	--	48.4	Gold has been produced from gossan
Taylor Brook	400	226.8	--	--	--	--	--	No grades reported
Lower 44 Mile Brook	401	--	0.09	0.70	2.46	0.41	18.86	ddh intersection, 1.63m
Murray Brook*	**414**	**1,542.2**	--	--	--	**1.27**	**51.09**	
Millstream Hendry	417	71.7	--	2.23	1.57	1.06	163.20	
Millstream Bridge	422	--	--	4.70	5.40	2.40	442.29	ddh intersection, 2.3m
Simpson Field*	**438**	--	--	--	--	**1.13**	--	**Trench sample, 12m**
Caribou*	**444**	**4,174.0**	--	**3.84**	**8.46**	**1.70**	**109.6**	
Elmtree*	**454**	--	--	--	--	**8.00**	--	**Trench sample, 9m**
Armstrong A	484	3,100.0	0.29	0.42	2.29	0.68	2.4	
Little Dipper Harbour	568	--	1.20	2.80	0.07	19.37	22.29	Chip sample, 0.5m across strike
Vernon Mine	662	--	4.82	--	--	3.00	34.28	Chip sample of vein
Millstream West*	**734**	--	--	--	--	**10.97**	--	**ddh intersection, 1.5m**
Middle River Gold*	**735**	--	--	--	--	**7.71**	-	**ddh intersection, 2.7m**

* properties short-listed as exhibiting some promise of being able to supply refractory gold ore

Note: data from NBDNRE Mineral Occurrence File

Additional criteria were selected to fulfil the third objective of this phase of the study. A property was considered unsuitable for the custom mill concept if:

1. the reported gold grade was below 1 g/tonne*, regardless of tonnage
2. it was classed as a massive sulphide deposit with no information available suggesting that its gold content was refractory
3. there was insufficient exploration to determine tonnage, grade or refractory nature of the gold
4. the gold content was apparently not refractory

*Whalen and Thibault (1989) report (pp. 89-90) a required cut-off grade of 5.0 g/tonne Au for the custom mill concept to break-even, financially, assuming revenues were generated only from gold; if revenues could also generate from the extraction of other metals (eg.silver), the cut-off grade for gold could be reduced; a somewhat arbitrary figure of 1 g/tonne Au was chosen for the selection criteria at this stage in this study (note: 5 g/tonne Au is approximately equivalent, in terms of revenue, to 1.25 g/tonne Au + 170 g/tonne Ag)

Of the 25 properties listed in Table 2.1.1 and subjected to the above listed selection criteria, 6 were short listed as exhibiting some promise of being able to supply refractory gold ore to a custom mill. The 6 properties short listed include Murray Brook, Simpson Field, Caribou, Elmtree, Millstream West, and Middle River Gold. Detailed descriptions of these properties are provided in Section 3.0. The 19 properties deleted from further consideration are briefly described below.

2.2.1 Cape Spencer

Map Sheet: 21H/04W
45° 11' 50": 65° 54' 50"

The Cape Spencer gold deposit, held by Gordex Minerals Ltd., was in production between October, 1987 and June, 1989. Originally, heap leach technology was used for gold extraction, later the mine converted to vat leaching. Quoted reserves include 550,000 tonnes averaging 2.28 g/tonne, proven and an additional 226,000 tonnes

averaging 2.06 g/tonne indicated (Northern Miner Press, 1989). Cyanidation recovers in excess of 95% of the gold present in the ore. At these recovery levels, a refractory gold processing circuit would not be considered viable.

References: Northern Miner Press, 1989
Ruitenberg et al., 1989 and 1990
Anderle et al., 1987
Stirling, 1987
Watters, 1986
Hattie et al., 1984
Jowsey et al., 1984

2.2.2 Lumsden

Map Sheet: 21H/15W
45° 47': 64° 50'

No information more recent than that reported in the Mineral Occurrence Files was found for this property.

References: Brown et. al., 1981
Carroll, 1981
Lockhart, 1980

2.2.3 Orvan Brook

Map Sheet: 210/09E
47° 37' 37": 66° 08' 07"

Recent work has failed to indicate gold grades higher than 1g/tonne.

References: Bugnon, 1986
Bugnon, 1985
Williams, 1974
Davis, 1983

2.2.4 Lavigne Brook

Map Sheet: 21P/2W
47° 41' 48": 65° 51' 50"

Work to date indicates this property is a low grade gold-silver prospect. Recent exploration has concentrated on the

adjacent Stevens Brook Claims group.

References: Fitzpatrick, 1987 a
Burton, 1985 b
Calhoun, 1984
Skinner, 1974
Davis et. al., 1969

2.2.5 Bradley Brook/Zarina

Map Sheet: 21P/12W
47° 40' 21": 65° 55' 52"

This property has received significant exploration attention in recent years. Some results have been spectacular, however, the deposit appears to consist of a narrow vein occurrence with little probability of any significant tonnage being discovered. An attempt was made to complete mineralogical studies on samples collected from this prospect (Stirling J., 1987). This however failed due to the low gold content of the samples submitted for study.

References: Ruitenburg et. al., 1990
Mann, 1988
Stirling, 1987
Kidd, 1977
Kidd et. al., 1976
Davies et. al., 1969

2.2.6 Madran (Hickey Showing)

Map Sheet: 21P/13W
47° 47' 20": 65° 51' 48"

Current exploration on this skarn (Section 7.0) deposit has obtained mixed results and does not suggest consistency of gold grades. A confidential report detailing exploration is due for release in November 1991.

References: Ruitenburg et. al., 1990
MacPherson, 1989 (Confidential)
Misner, 1988
Burton, 1985 a
New Brunswick Dept. of Natural Resourses and Energy, 1986

2.2.7 Restigouche

Map Sheet: 210/10E
47° 30' 06": 66° 33' 02"

Recent information indicates that this deposit will go into production. It is advisable to closely monitor gold recoveries in order to determine whether a refractory gold content is being lost to the tailings.

References: Barrie et. al, 1982
Mercer, 1975

2.2.8 Louvicourt District

Map Sheet: 21P/05W
47° 23' 25": 65° 55' 59"

Recent exploration has failed to increase either gold reserves or their average grade.

References: Work, 1985
Powers et. al., 1982
Leslie et. al., 1978
Gummer, 1976

2.2.9 Captain Deposit

Map Sheet: 21P/05W
47° 17' 03": 65° 52' 58"

This deposit, along with its northern extension have recently been actively evaluated. Updated reserves of 31,998 tonnes grading 1.56 g/tonne Au in the core of the deposit and 1,451 tonnes grading 0.06 g/tonne Au beneath the gosson are reported (Whaley, 1988). Additional work, however, is required to determine the true potential of the deposit as a gold producer. The gold appears to be associated with base metal minerals in the form of tellurides (Tupper, 1968) and would report with them during processing.

References: Whaley, 1988
VonGuttenburg, 1980
Williams, 1976
Tupper, 1968
Stratabound Minerals Corp., 1988
Skinner, 1974

2.2.10 Canoe Landing Lake

Map Sheet: 210/08E
47° 24' 39": 66° 06' 24"

This large tonnage, low grade deposit is not amenable to traditional massive sulphide processing. Metallurgical tests have indicated problems in base metal recovery and the gold content is too low for consideration on its own.

References: New Brunswick Mining Industry, 1986
Brooks, 1985
Brooks et. al., 1983
Brooks et. al., 1981
Stairs, 1980

2.2.11 Nerepis Gold

Map Sheet: 21G/08W
45° 23' 35": 66° 18' 00"

This gold prospect has been actively explored in recent years. Most of the work reported has been geochemical; one filed assessment report will remain confidential until December 1991.

References: Brown, 1989 (Confidential)
Ruitenburg et. al., 1989
Whaley, 1987 a and b

2.2.12 Heath Steele: A,C,D zones

Map Sheet: 210/08E
47° 17' 28": 66° 05' 13"

Recent work has concentrated on production of the gold contained in the gossan overlying the deposit. It is suspected that a portion of the gold content associated with the base metals

is refractory in nature. Evaluation of its recovery is worth consideration.

References: Davies et. al., 1983

2.2.13 Taylor Brook

Map Sheet: 210/08e
47° 20' 43": 66° 00' 35"

This deposit is a very low grade massive sulphide deposit. Recent exploration has increased the reserves although gold grade remains marginal.

References: Northern Miner Press, 1989
Duffy, 1986
Duffy, 1984
Gummer, 1978
New Brunswick Department of Natural Resources and Energy, 1978

2.2.14 Lower 44 Mile Brook (Essex Zone)

Map Sheet: 210/08E
47° 24' 42": 66° 11' 50"

Very little information, either present or past, exists to classify this property. No additional information was unearthed to augment that reported on Table 2.1.1

References: Pitre et. al., 1981
Mersereau, 1980

2.2.15 Millstream Hendry

Map Sheet: 21 P/12W
47° 39' 53": 65° 56' 41"

Assessment reports which have recently been made public for this massive sulphide deposit indicate that more recent exploration has not succeeded in outlining additional reserves or increasing the grade beyond that reported previously.

References: Dimmel, 1987 a
Kidd and Pearson, 1987

2.2.16 Millstream Bridge

Map Sheet: 21P/12W
47° 40' 48": 65° 52' 30"

Exploration on this property has been active in recent years with at least two confidential reports held in the assessment files. Public information, however, shows little beyond the fact that the property is a base metal prospect bearing gold.

References: Fitzpatrick, 1989 (confidential)
Dimmel, 1987 b
Fitzpatrick, 1987 b
Davies et. al., 1969

2.2.17 Armstrong A

Map Sheet: 21O/09E
47° 36' 06": 66° 02' 33"

Reserves tabulated on Table 2.1.1 are after Williams (1974). To date no further refinement of these figures is reported.

References: Mersereau, 1988
Mersereau, 1986 b
Mersereau, 1985
Buzas, 1974

2.2.18 Little Dipper Harbour (Cox Prospect)

Map Sheet: 21G/01W
45° 06' 38": 66° 22' 16"

Recent drilling on this property has failed to uphold the high gold values reported from trenching (Table 2.1.1). The gold is intimately associated with sulphides.

References: Cox et. al., 1985

2.2.19 Vernon Mine

Map Sheet: 21H/11E
45° 31' 24": 65° 08' 06"

The available data base for this property suggests that it

generally appears to be similar in type to the Cape Spencer gold deposits. The gold mineralization is apparently associated with pyrite.

References: Whaley, 1989
Whaley, 1985
Whaley, 1981

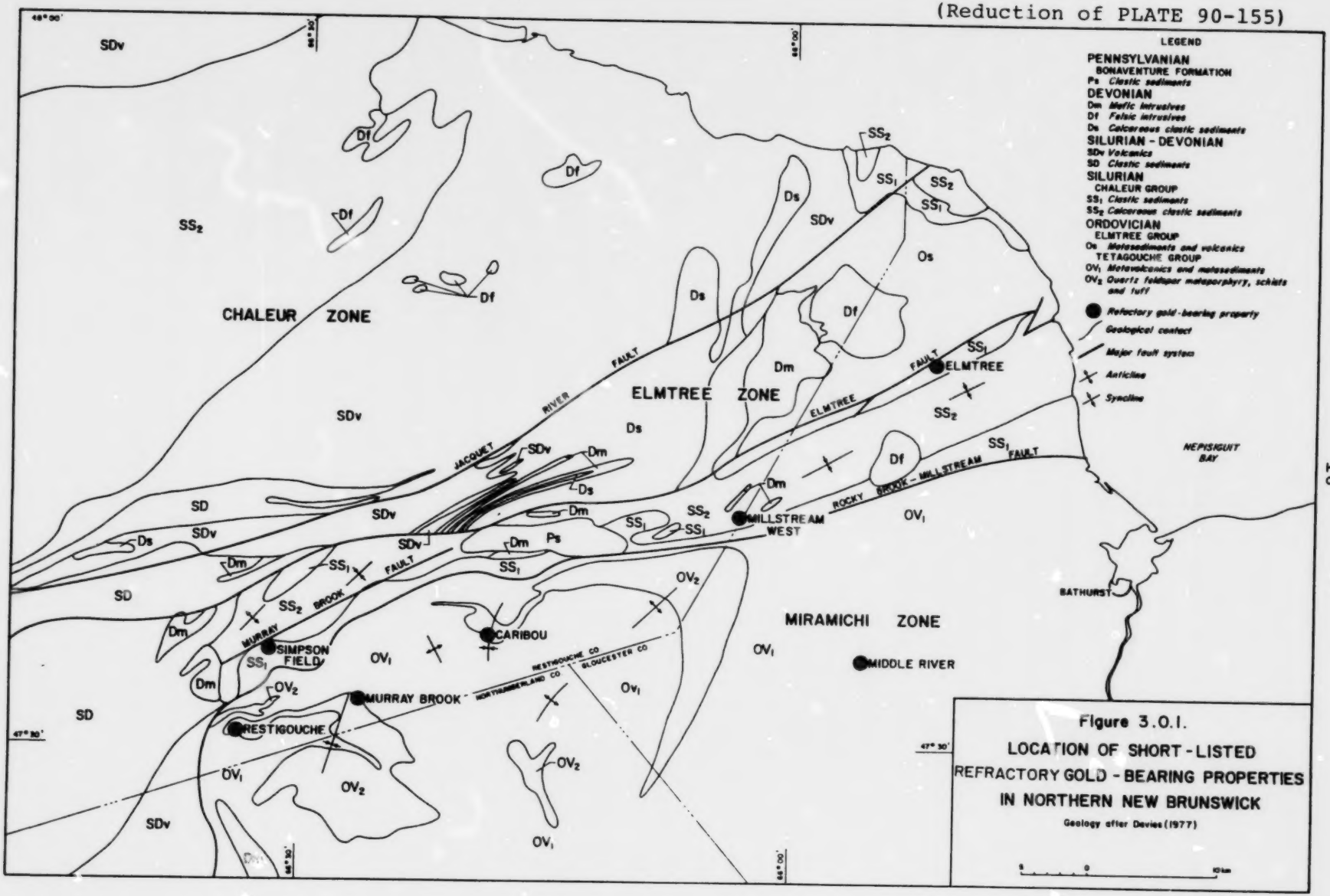
3.0 TARGETED PROPERTIES

Six properties were short listed since they exhibited some promise of being able to supply refractory gold ore to a custom mill. Four of these properties are similar in both type and apparent mode of emplacement. Three of the four, the Simpson Field, Elmtree and Millstream West properties, are all related to diabasic intrusives cutting Silurian metasediments. All occur within or around the fringes of a large regional Silurian Synclinorium (Davies et. al., 1969) south of the Elmtree and Chaleur Tectonostratigraphic Terranes (Figure 3.0.1). The fourth, the Middle River Gold property, is located in deformed Ordovician metasediments and metabasalts south of the Rocky Brook-Millstream Fault, in the Miramichi Zone. The other two properties, Murray Brook and Caribou, are both producing base metal deposits which could possibly supply tailings bearing refractory gold to a custom mill. In the case of Murray Brook, current production is for gold only and originates from the gosson cap. The unoxidized primary ore body and/or an associated auriferous pyrite halo may bear refractory gold.

3.1. ELMTREE DEPOSIT

The Elmtree Gold deposit, currently held by Corona Corporation, is located about 7km west of Highway 11 and 15km southwest of Brunswick Smelting's Belledune smelter (Map Sheet 21P/3W; 47° 46' 05": 65° 52' 01"). The deposit is accessed via the villages of Laplante, Alcida and Dauversiere and straddles the south branch of the Elmtree River. The deposit consists of the so-called Discovery and West Gabbro zones. The latter holding all of the drill indicated geological reserves of 500,000-750,000 tonnes grading 4.38 g/tonne (D. Hoy, 1990, personnel communication). The Discovery zone is currently classed as sub-economic.

(Reduction of PLATE 90-155)



Exploration work completed to date includes geological mapping, ground geophysical and geochemical surveys, trenching and drilling, totalling 6,323 metres comprising 50 holes. The West Gabbro zone has experienced the bulk of this drilling with reserves being calculated from 45 holes totalling 5,891 metres.

The discovery of the Elmtree deposit by Lacana in the mid-1980's sparked a flurry of exploration activity in similar geologic terrains. Much of this exploration activity, reports of which are now in the public domain, was of an initial "grass roots" nature and was successful in identifying other (than Elmtree) similar gold occurrences. More recently completed follow-up work on these properties is as yet confidential or is not advanced to a stage whereby categorization of all or part of their gold content as refractory is possible.

3.1.1 Geology

The Elmtree deposit is classed as an epigenetic (Section 7.0) gold deposit comprised of quartz-carbonate type vein mineralization (Ruitenberg et.al., 1989). It is hosted by a moderate to intensely altered gabbroic (Section 7.0) sill (Section 7.0) bounded by a succession of argillaceous (Section 7.0), slaty metasediments. These are gradational into cherty (Section 7.0) hornfels proximal to the intrusive contact. The sill has been traced by drilling for a strike length of 366 metres and vertical depth of 244 metres. It pinches and swells along its length with an average thickness of 16.7 metres. Locally the gabbro is strongly silicified with pervasive carbonatization (Section 7.0) throughout. Significant gold values have been outlined over a strike length of 244 metres and total vertical depth of 204 metres.

Sulphide mineralization appears closely related to quartz veining and auriferous zones typically contain 30-35% sulphides. Arsenopyrite, pyrite and pyrrhotite predominate with lesser amounts of chalcopyrite, sphalerite and stibnite.

Typically the sill has a coarse-grained strongly foliated anorthositic (Section 7.0) core. Grain size is gradational to fine-grained near metasedimentay contacts. The hornfelsic contact also carries significant gold locally but does not host gold as well as the gabbro.

Ductile and brittle deformation is locally very intense within the sill. Petrographic analysis indicates that the original igneous textures are not well preserved (Hoy, 1986). Also the original mineralogy of the gabbros consists of calcic plagioclase and at least one mafic mineral.

The permeability induced by shearing which the rocks have been subjected to has permitted oxidation to penetrate the deposit to depths of several tens of metres. Oxidation affects the rocks along the shear and joint planes with the result that parallel to these planes, the rocks have developed a rind of oxidation products. The intensity of the oxidation decreases with depth and is proportional to the degree of shearing.

The rocks surrounding the deposit consist of (Figure 3.0.1) the Elmtree Group, of Ordovician age, and the Chaleur Bay Group, of Silurian age. These formations are in fault contact with one or another. The Elmtree Group near the deposit consists of thinly laminated dark grey phyllite and argillite. A coarser grained equivalent consisting of metagreywacke, grits and conglomerates exists primarily along the faulted contact with the Chaleur Group. Adjacent to the ultra-mafic intrusives, the metamorphosed equivalent of these rocks consist of cherty hornfels and conglomerate in addition to skarns. There is usually a 6-7.5 metre contact aureole surrounding the mafic intrusives. The Chaleur Bay Group consists of two distinct lithological units. Unit SS_1 consists of a green to grey pebble cobble conglomerate with a calcareous matrix. Unit SS_2, lying farthest from the deposit, is composed of green/buff phyllite, argillite and calcareous siltstone.

3.1.2 Structure

The Elmtree deposit occurs along a shear-fracture system known as the Elmtree Fault. This is the regional control on all mineralization discovered on the property (Hoy, 1986). This break has been shown in trenches to be a series of en-echelon shears up to 45 metres wide and trending approximately 60-70°. Secondary fracturing and faulting occurs generally between 300° - 40°. Minor sulphide veins have been noted with trends similar to this secondary fracturing.

Fold axes within the Elmtree Group plunge shallowly to the east as does the gabbro on its east end. The mineralized zone within the gabbroic sill has been mapped through drilling as plunging more steeply to the east.

3.1.3 Mineralogy

To date three different types of structurally controlled mineralization are recognized on the property (Hoy, 1986). These include:

1. quartz-sulphide veins
2. arsenopyrite impregnated siltstones
3. arsenopyrite-pyrite-pyrrhotite impregnated gabbro

All three types are auriferous and are economic to sub-economic.

The quartz sulphide veins are relatively narrow polymetallic veins and are generally found hosted by silicified (Section 7.0), brecciated argillites and cherty hornfels. The veins are structurally controlled within shear zones, 1.5 - 3.0 metres in thickness. Alteration within the shear-fracture zones includes silicification, sericitization and carbonatization. Mineralization includes up to 80% combined sulphides including pyrite, arsenopyrite, sphalerite, galena, stibnite, and pyrrhotite; magnitite is also present. Gold values consistently assay 1.6 to

6.2 g/tonne with trench chip sampling obtaining grades of 3.4 g/tonne over 2.4 metres. Drilling within these shear zones have upheld values obtained at the surface although over much narrower zones of 30 - 90cm. Petrographic and sample analysis have indicated gold grades tend to increase with an increase in abundance of arsenopyrite and sphalerite.

The arsenopyrite impregnated siltstones are found south of the Elmtree Fault within the Chaleur Bay metasediments. Mineralization appears intimately associated with the margins of fine-grained, massive felsite (Section 7.0) dykes located proximal to the Elmtree Fault. Subeconomic values obtained from these zones are from drilling. Grades of 2.29 g/tonne gold across 4.42 metres and 2.8 g/tonne gold over 76cm have been obtained. Mineralogically the altered zone consists of silicified, sericitized and carbonatized phyllites with disseminated arsenopyrite and pyrite crystals. Surface expressions of the zones are gossonous and friable siltstones. As with the other types of gold mineralization, these grades also tend to increase with an increase in arsenopyrite.

Arsenopyrite-pyrite-pyrrhotite impregnated gabbro is the most important style of mineralization from an economic point of view. The West Gabbro zone is classed in this type of mineralization. Generally high gold values within the intrusive are associated with the abundance of sulphides and the extensiveness of hydrothermal alteration and accompanying deformation. Structurally controlled high grade zones also appear to exist within the sill (Hoy, 1990, personal communication).

The West Gabbro intrusive ore body has been thoroughly investigated both petrographically and geochemically (Stirling, 1987; Davison, 1988; Miller, 1988; Hoy, 1988). Clearly, gold mineralization is closely associated with sulphides particularly arsenopyrite. Associations have also been noted with pyrite and

pyrrhotite as well as a possible solid solution phase with arsenopyrite.

Polished thin section microscopy and microprobe analysis were performed by Miller (1988) on thirty-four samples taken from drill core from various depths in the West Gabbro Zone. These analysis were used to define the following mineralogy.

Pyrite (FeS_2) is the most abundant sulphide mineral present, accounting for approximately 35-40% of the total sulphides. Pyrite grains range from euhedral (Section 7.0) to anhedral (Section 7.0) grains up to 1.5mm across. The grains are often clustered to form massive sulphide blebs. Individual grains frequently contain inclusions of arsenopyrite, pyrrhotite, galena and chalcopyrite as well as a few micrograins of native gold (less than 0.05mm). Many subhedral (Section 7.0) grains are highly fractured and may contain infillings of sulphosalts (jamesonite and boulangerite).

Arsenopyrite (FeAsS) accounts for approximately 30% of the sulphide minerals present and is characteristically in the form of rhombohedral blades, 0.5 millimetres long. Inclusions of euhedral arsenopyrite occur in grains of pyrite, pyrrhotite and sphalerite.

Sphalerite [(Zn,Fe)S] is locally abundant, constituting up to 10% of the metallic minerals. The grains are anhedral, individual grain boundaries are indistinct. Sphalerite grains host inclusions of euhedral pyrite, arsenopyrite, pyrrhotite, chalcopyrite and stannite. Sphalerite rich bands exist throughout the host rock.

Galena (PbS) forms large (2mm) anhedral grains and may locally constitute up to 5% of the sulphide minerals. Galena may enclose inclusions of pyrrhotite, arsenopyrite and chalcopyrite. Grains of galena are present which are totally enclosed by pyrite.

Pyrrhotite ($Fe_{1-x}S$) makes up a minor phase (less than 10%) of the sulphide mineralogy. Pyrrhotite laths up to 3mm long are often clustered together. These large grains are usually extremely pitted and may be host to micro grains of native gold.

Chalcopyrite ($CuFeS_2$) constitutes up to 4% of the total sulphides present. It occurs as euhedral grains up to 1mm in diameter and occurs throughout as scattered blebs. Microprobe analysis identified the silver content in certain grains of chalcopyrite to be approximately 1000 ppm.

Rutile (TiO_2) and ilmenite ($TiFe_2O_5$) make-up approximately 3% of the metallic minerals. Skeletal ilmenite up to 1mm long is common. In gangue (Section 7.0), ilmenite pseudomorphs after feldspar grains are present. Rutile usually occurs with ilmenite as irregular masses of fine-grained material (less than 0.01mm).

X-ray diffraction analysis identified boulangerite ($Pb_5Sb_4S_{11}$) as the locally abundant sulphosalt. The microprobe, however, identified jamesonite ($Pb_4FeSb_6S_{14}$) as the major sulphosalt. Quantities of these two minerals appear to vary locally. Anhedral jamesonite is often observed surrounding grains of euhedral pyrite.

Native antimony and the alloy allargentum (3:1 ratio of Ag:Sb), identified by microscopy and microprobe work, appear to be closely related to the antimony-containing sulphosalts. Native antimony is found as small grains (less than 0.05mm) with the sulphosalts.

Stannite (SnO_2) and cassiterite (Cu_2FeSnS_4) are usually found as small inclusions (less than 0.05mm) in the sulphosalts and in sphalerite.

Native gold is widely dispersed. The gold occurs as micro grains (less than 0.01mm) in contact with pyrite, pyrrhotite and

arsenopyrite and sometimes as inclusions within these minerals. A minor number of large (0.15mm) grains of gold have been noted. Native gold also occurs as free grains with the gangue.

Drill core pulps from a section through the central part of the gabbro sill were systematically analyzed by Lacana (Hoy, 1988) in order to determine the variations in major and trace elements through the sill. The section included both mineralized and unmineralized gabbro. The auriferous zone, comprising coarse grained, highly altered anorthositic gabbro, assayed 6.0 grams/tonne gold across 11 metres. The intrusive phases flanking the auriferous zones are comprised of moderately to strongly altered, fine to medium-grained gabbro. Both upper and lower intrusive contacts are characterized by the development of cherty hornfels in the enclosing sediments.

The drill pulp analysis profile shows a strong, positive correlation of arsenic with the auriferous zone; arsenopyrite is the most abundant sulphide in the gold-bearing zones. Moderate, positive correlation of silica, iron and sodium are present whereas moderate, negative correlation of magnesium and calcium exist in the gold zone. Vanadium, cobalt, nickel and chromium are depleted in the gold zone.

3.1.4 Reserves

Hoy (1986) has calculated ore reserves of 453,720 tonnes of undiluted material grading 4.35 g/tonne Au. Calculations were based on a deposit dimension of 500' X 500' X 20' (152m X 152m X 6m). A total of 45 holes totalling 5,891 metres were used to outline the tonnage as well as surface trenching. More recently (Hoy, personnel communication, 1990), reserve figures of up to 750,000 tonnes, having similar grade, have been suggested for the deposit. Additional reserves are thought to exist down plunge although no exploration in search of these has been completed.

3.2 MILLSTREAM WEST PROSPECT

The Millstream West prospect, currently held by Acadia Mineral Ventures Ltd., originally comprised 10 mineral claims located on Map 210/09E (47° 39' 45": 66° 01' 40"). The property has since been expanded to include adjoining prospects of similar types on adjacent claims. The prospect is approximately 19 kilometres west-northwest of Bathurst and is accessed by secondary roads passing through Robertville and Sormany.

The prospect consists of multiple diabasic (Section 7.0) dykes and dyke swarms which locally host gold and silver values of sub-economic values. To date no geological reserves have been calculated for this prospect.

Exploration work to date has included geological mapping, ground geophysical and geochemical surveys, trenching and drilling on various areas of the property.

3.2.1 Geology

The Millstream West property lies along the extensions of the Rocky Brook - Millstream Fault, on the south limb of a large Silurian synclinorium (Davies et. al. 1969). Regional formational units include the Chaleur Group, SS_1 and SS_2 metasedimentary members (Figure 3.0.1). Locally these members consist of greenish grey siltstones, greywackes and conglomerates.

Ordovician members of the Tetagouche Group lie to the south of the Rocky Brook - Millstream fault. These are represented as the metavolcanic members Ov_{1-2} in Figure 3.0.1. Locally these occur as phyllitic-graphite schists, meta-greywacke and marble. Cutting the Ordovician sediments are mafic plugs, dykes and sills of a younger age. The Silurian sediments are likewise intruded by numerous

diabasic and gabbroic dykes of Siluro-Devonian age ranging from 0.5 to 10 metres in width.

To date 43 diamond drill holes on various targets, identified by previous geochemical and geophysical exploration surveys, have located numerous diabasic dykes and dyke swarms. It is clear after examination of recent assessment reports that mafic dykes of sub-economic to economic grade do exist on the property (Gardiner, 1988a, 1988b, 1989). The highest gold values were consistently located along the contacts of the intrusives and the metasediments. Occasionally the entire dyke hosts moderate grades of gold mineralization.

3.2.2 Mineralogy

To date the main type of mineralization noted consists of disseminated and massive veins of pyrite and/or arsenopyrite hosted by the mafic dykes and the adjacent altered calcareous siltstones.

The main type of economic mineralization found within the altered metasediments is generally pink to red in colour, but locally may be pale green. Alteration is due to silicification of the sediments flanking quartz and quartz-carbonate veins and veinlets of various orientations. In addition to pyrite and arsenopyrite, minor epidote, illite and fuchsite occur throughout the alteration (Lewczuk, 1988). The quartz-carbonate (ankerite) veins are of two types, a quartz-carbonate vein which does not appear to be related to alteration and a quartz-ankerite or siderite vein which is intimately associated with alteration. Petrographic investigation indicate these veins also contain minor amounts of adularia, monazite, apatite and ilmenite.

Two types of sulphide mineralization occur in the altered zone. A disseminated type is comprised of cubic pyrite crystals and irregular masses of variable size. Arsenopyrite almost always

occurs as fine needles and rarely as coarse crystals. A vein type of sulphide mineralization is characterized by massive to semi-massive bands of pyrite and arsenopyrite in quartz-ankerite veins.

Petrographic studies have been conducted on the vein type mineralization and gold has been shown to occur as electrum. Chemical analysis indicate a Au:Ag ratio close to 3:1. The electrum occurs as 1-25 micron (averaging 10 micron) inclusions in pyrite or on the pyrite-arsenopyrite interfaces. Chalcopyrite veinlets which dissect the arsenopyrite may also contain electrum. Gold has also been noted to occur within arsenopyrite aggregates in one sample.

Structural control of veining and mineralization is not well understood in this early stage of exploration. Veins do appear to form a ladder-like pattern within the dykes and locally in wallrock which exhibits minor deformational shearing.

3.2.3 Grade

As stated previously, gold grades are highest at the intrusive-host boundaries, although some dykes have moderate grades of gold over the total dyke thickness. One intersection had contact grades of 28.0 and 32.0 g/tonne Au over 15cm respectively while the dyke thickness of 2.5 metres graded 3.1 g/tonne Au.

Other sub-economic intersections have the following grades (Gardiner, 1988a, 1988b, 1989):

1. 1.40 g/tonne Au, 130.0 g/tonne Ag over 9.66m
   including one section of
   2.80 g/tonne Au, 95.2 g/tonne Ag over 1.3m
2. 2.80 g/tonne Au, 270.0 g/tonne Ag over 1.3m
3. 4.60 g/tonne Au over 1.8m
4. 6.00 g/tonne Au over 2.23m
5. 3.00 g/tonne Au over 1.39m
6. 7.38 g/tonne Au over 1.72m
7. 4.60 g/tonne Au over 1.7m

8. 2.70 g/tonne Au over 0.96m
9. 3.55 g/tonne Au over 6.34m

Many other lower grade intersections over wider widths up to 42.4 metres have recently been identified. While no reserve estimates are reported, exploration is continuing to locate mineralization.

3.3 SIMPSON FIELD PROSPECT

The Simpson Field prospect is currently held by Michael Smith and is under a 50-50 joint venture option to Norex Exploration and Brunswick Mining and Smelting. The property occurs on the south east corner of NST Map Sheet 210/10E (47° 33' 46": 66° 31' 45"). Access to the property is via all-weather gravel and logging roads and is located approximately 50 kilometres west of Bathurst.

The property is still in its early stages of exploration and is included in this report due to geologic similarities to previously described properties. Current exploration and petrographic studies have indicated the prospect contains refractory gold in association with diabase dykes.

Adjacent mineral claims and prospects including Dalhousie Road and Mulligan Gulch have also been explored by Brunswick Mining and Smelting although these reports are as yet confidential.

Exploration completed to date on the Simpson Field prospect has included geological mapping, ground geochemical and geophysical surveys, trenching and drilling. Major participants in this exploration have included Fitzpatrick and Clemson (1986), and Bonham (1986). The exploration emphasis has been directed towards auriferous mafic intrusives.

3.3.1 Geology

The property lies on the western extent of a large Silurian synclinorium (Davies et. al, 1969). The Rocky Brook - Millstream Fault, separating the Chaleur and Tetagouche Groups, is found to the south and the Murray Brook fault cuts the centre of the property.

The property is positioned within the Chaleur Group member SS_{1-2} (Figure 3.0.1) and is locally represented by mafic intrusives of Devonian Age (Unit Dm_1, Figure 3.0.1). Sediments and mafic volcanics of slightly younger age (Ds; Dv) lie to the west of the prospect, with Tetagouche sub-aqueous volcanics to the south (Ov_{1-2}).

The main area of exploration activity on this property has been an intensely altered diabasic intrusive and its host sediments. The area has been explored by five trenches and six diamond drill holes totalling 908.6 metres. Gold of economic grades has not as yet been located, although exploration on this prospect and adjacent ones is continuing.

3.3.2 Mineralogy

The auriferous mafic intrusives have been locally silicified and carbonatized. Siderite is the major carbonate mineral and pyrite the major sulphide mineral in the highly altered zones.

Thin and polished sections from the prospect have been studied by two separate petrologists (Fitzpatrick and Clemson, 1986 and Stirling, 1987). The samples studied were from highly altered silicic, calcareous, pyritic zones of the prospect. Basic mineralogy consisted of quartz, siderite, pyrite and hematite/limonite +/- minor chalcopyrite, sericite and biotite. Gold appears to be associated with pyrite either at pyrite-pyrite grain boundaries or locked within single pyrite grains. Gold grains average 6.2 microns and ranging from 0.5 to 44.6 microns (Fitzpatrick et. al., 1986). Where gold occurs as inclusions in pyrite, the pyrite is usually zoned. Microprobe analysis of this type of pyrite appears to be a result of arsenic and possibly gold in solid solution with pyrite (Stirling 1987). Gold in one sample appeared unrelated to pyrite and in association with siderite and quartz.

3.3.3 Grade

No major economic or sub-economic drill intersections or trench channel samples have been outlined on the prospect. Trenching activities have been the source of the best gold grades to date, however, drilling has failed to delineate any extent to the auriferous zones exposed at surface.

The highest grades exposed at surface are listed below:

1. 1.29 g/tonne over 6.0m including
   7.28 g/tonne over 1.0m
2. 1.20 g/tonne Au over 1.4m

Mapping of trenches has outlined cross cutting gold bearing fracture-sets and gouge zones which are perpendicular to stratigraphy. These suggest that gold mineralization is at least in part controlled by these structures.

3.4 CARIBOU DEPOSIT

The Caribou deposit is primarily a lead, zinc, silver deposit bearing subsidiary gold. The deposit is currently being mined by Breakwater Resources Ltd., whose majority shareholder is Corona Corp.

The mine site is located on Map Sheet 210/09W (47° 33' 39": 66° 17' 38"), approximately 4 kilometres south of New Brunswick Provincial Highway 180 and north of the Restigouche-Gloucester county line.

The deposit contains approximately 11,000,000 tonnes of 12% combined lead-zinc ore. The ore is fine-grained, which poses milling and concentrating problems. Approximately 10% of the calculated gold reserves report to the concentrate, the remaining gold reports to the tailings. This relatively poor gold recovery is suspected to be due to its association with pyrite (and resultant refractory nature).

3.4.1 Geology

The Caribou deposit has been assessed by a variety of geologists. The description given herein is after Roscoe (1971) and Cavalero (1972).

Like other stratiform massive sulphide deposits of the Bathurst type, the Caribou deposit occurs in a volcanic complex within the Ordovician Tetagouche Group. Locally it occurs within a transitional phase of the silicic (Ov_{1-2}, Figure 3.0.1) tuffaceous (Section 7.0) rocks and graphitic argillaceous rocks (Ov_1).

The deposit consists of three or more en-echelon tabular, massive and conformable sulphide bodies. These lenses are contained within the so called Ore Zone Unit. This unit is

subdivided into volcanic, sedimentary and sulphide facies. The two former facies grade with increasing sulphide content into the latter. The metasedimentary facies occur as the footwall and the metavolcanic schists occur as the hanging wall of the deposit. The entire deposit has been folded locally into a northerly plunging synclinal fold. Length of individual lenses range up to 2,048 metres with widths in excess of 30 metres. Total length of the mineralized zone is 1,524 metres and its depth is unknown.

Above the sulphide lenses is a zone of supergene (Section 7.0) sulphides enriched in copper. This zone varies from a few metres to 42 metres in thickness. Above this is a zone of gossan varying from 0 - 12 metres in thickness.

3.4.2 Structure

Three phases of deformation have affected the Caribou deposit. The first phase occurred in Ordovician time as a result of the Taconic Orogeny. Regional isoclinal folds, low grade regional metamorphism and development of a dominant schistosity are seen as effects of this phase. The emplacement of the massive sulphides either accompanied or preceded this deformation.

The second phase of deformation occurred during the Devonian Acadian Orogeny and occurs as well developed kink-folds in all rocks throughout the mine.

Development of the Caribou fold was the final structural event. It occurred during the Acadian Orogeny and uniformly folds the S_1, sulphide lenses and the lithologic units. This phase is also associated with faulting in the Caribou area. Strike separation as much as 30 metres has been documented along these fractures.

3.4.3 Mineralogy

The ore zone in the Caribou deposit is composed of massive sulphide lenses with intercalations of silicic metavolcanic and metasedimentary rocks. The most abundant sulphide mineral in the ore zone is pyrite followed by sphalerite and galena with minor to negligible amounts of chalcopyrite.

The Caribou synform (Section 7.0) hosts three sulphide lenses on its west limb and a fourth on its east limb. The three west limb lenses have similar characteristics. The minerals are very fine-grained and consist of predominantly pyrite with sphalerite, galena and magnitite. The lenses are zoned both laterally and vertically. Lead and zinc sulphides are concentrated along the hanging wall, copper locally along the foot wall and a pyritic central core zone. A ratio of Pb:Zn is 3:1 with silver values correlating proportionately to this ratio. Gold is less dependant on these minerals and has been noted to associate with arsenopyrite in low grade areas. There is a distinct absence of pyrrhotite contrary to other deposits in the area. Chlorite is the chief gangue mineral and quartz-carbonate veins are common.

The east limb lens is similar, but shows a few distinct differences. Vertical zoning is absent; one end of the body has high lead:zinc values with ratios approaching 2:1; these grade into a pyritic zone towards the opposite end. Magnetite content is low to absent, and the chief gangue mineral occurs as quartz-phyllite lenses (Cavalero, 1972).

Lenses of both limbs of the Caribou synform have chalcopyrite and arsenopyrite as minor minerals. Trace quantities of pyrrhotite, marcasite, rutile, illite, tennantite, tetrahedrite, hematite, covellite, bornite, chalcocite, jarosite, plumbojarosite, and goethite have been found to exist within the sulphides. (Roscoe, 1971; Cavalero, 1972; Gondhi, 1977; Mercer, 1975).

Gold correlates positively, although weakly, with lead, zinc and silver values in the deposit. Gold is highly enriched in the sulphides in comparison to the host rocks and a zonation exists within the enclosing rock with gold content increasing as the ore body is approached. It probably occurs as the native metal and is preferentially concentrated in pyrite relative to the co-existing sulphides (Mercer, 1975).

3.3.4 Reserves

East West Minerals, N.L. (1988), the former property owners, have calculated reserves based on drilling records, extensive sampling of all underground development and recent ore delineation drilling. Using a 12% combined Pb-Zn cut-off at a minimum width of 1.5 metres, reserves were determined to be:

	Tonnes	Zn (%)	Pb (%)	Ag (g/tonne)	Au (g/tonne)
Proven ore	2,079,700	8.29	3.69	103.80	1.57
Indicated ore	3,349,300	8.59	4.05	119.09	1.72
Inferred ore	5,492,200	8.37	3.59	101.76	1.78

These values were later confirmed by consulting engineers and geologists although a third party calculation later altered these values to those shown below:

	Tonnes	Zn (%)	Pb (%)	Ag (g/tonne)	Au (g/tonne)
Proven ore	1,882,000	8.29	3.69	101.9	1.6
Indicated ore	2,292,000	8.60	3.96	116.0	1.7
Inferred ore	7,000,000	12% combined		not available	

3.4.5 Production

A maximum of 2,000 tonnes of ore will be processed per day with an estimated annual production of 700,000 tonnes. A total of 124,120 tonnes of zinc-lead concentrate will be produced.

Expected recoveries in the concentrate for each tonne of ore processed are:

Zn - 49 kg
Pb - 22 kg
Ag - 41.67 grams
Au - 0.16 grams

In the context of this study, the obvious deficiency in these figures is that only 10% of the gold reports to the concentrate. The loss of up to 1.5 grams of gold/tonne of ore processed results in excess of 1,000,000 grams of gold being disposed of annually with the tailings. In addition, only 38% of the silver is recovered, resulting in the disposal of approximately 67 grams of silver/tonne of ore processed. This equates to a loss of over 45,000,000 grams of silver annually, in addition to the losses of gold.

3.5 MURRAY BROOK DEPOSIT

The Murray Brook deposit is a massive sulphide deposit operated by NovaGold Resources Inc. Current development and exploration have centred on the gossan cap (Pitman, 1985) which is currently being mined and vat leached for its gold and silver content.

The deposit is located on NTS Map 21)/09W (47° 31 31": 66° 25' 51") approximately 80 kilometres west of Bathurst and 10 kilometres west of the Caribou deposit.

The massive sulphides of the primary (unoxidized) deposit are found mainly within a single lens approximately 396m X 335m X 60m. Two other separate lenses have recently been located 1400m southeast and 500m east of the main deposit (Rennick, 1989). Estimated reserves are 21,400,000 tonnes grading 0.44% Cu 0.86% Pb, 1.95% Zn and 28 g/tonnes Ag. A study is currently under way to recalculate reserves using updated information.

Recent information (Burton, personnal communication, 1990) indicates the presence of an auriferous disseminated pyrite halo adjacent to the primary deposit.

3.5.1 Geology

The Murray Brook massive sulphide lenses occur near the base of a volcanic sedimentary unit (Ov_2) located in the Ordovician Tetagouche Group (Ov_{1-2}, Figure 3.0.1). Further east, the Caribou deposit is also located near the centre of the same volcanic unit (Rankin, 1981). The deposit is conformable with a sedimentary sequence of siltstones and thin interbeds of volcanic tuffs (Ov_2). Locally these rocks have been intruded by Ordovician gabbro, diabase and quartz-feldspar porphyry (Section 7.0) dykes and sills.

The unconformable Silurian Chaleur Group sediments (Ss) lie a few kilometres to the north of the deposit.

The deposit lies on the upright limb of an F_1 isoclinal fold and on the east limb of an open F_3 fold and consequently dips gently northeast and plunges 40° to the northwest (Rankin, 1981). Numerous faults cut these folds with undetermined displacements.

3.5.2 Mineralogy

The primary sulphide body of the Murray Brook deposit is enclosed within a siltstone unit composed of quartz and sericite with minor calcite, chlorite and pyrite. A chloritic mudstone or iron formation is confined to the immediate foot wall of the lens and is discontinuous with limited lateral extent.

The primary sulphides are surrounded by a narrow envelope of disseminated sulphide. This fringe contains an average of 20-40 percent pyrite and averages 1 to 4 metres in thickness. Locally, widths of 10 metres have been intersected. Generally the pyrite is uniformly disseminated throughout a fine-grained light grey-white groundmass of quartz, sericite, carbonate and chlorite. Pyrite crystals are between 50-400 microns in size and grade with increasing abundance into the massive sulphides. Current exploration by NovaGold has indicated that this outlying disseminated pyrite zone is auriferous (Burton, personal communication, 1990). While details of this zone are limited, the implications of its refractory nature are certainly worthy of further investigation.

The massive sulphides at Murray Brook contain an average of 80-90 percent sulphide. Pyrite is the most abundant followed by sphalerite, galena, arsenopyrite, chalcopyrite, pyrrhotite, magnetite, marcasite, and tetrahedrite. Locally arsenopyrite replaces pyrite as the dominant sulphide. The main gangue minerals

are quartz and carbonate. Chlorite is also common although not as abundant as quartz and carbonate. The known association of gold with the sulphides, which are comprised predominantly of pyrite and locally arsenopyrite, suggests that the gold is likely refractory.

Compositional banding between pyrite-sphalerite, pyrite-sphalerite-galena or pyrite-gangue often exists in the sulphide lens. Usually this is in the form of thin laminae, 0.5-1.5 millimetres thick. Pyrite crystals can also be found to exhibit a grain size compositional variation.

The mineralogy of the massive sulphides has been studied in detail (Rankin, 1981). A total of 70 polished thin sections were obtained from available drill core and the occurrence, distribution, grain size and relative abundance of observed minerals summarized.

A calcareous mudstone is found as beds or lenses within the sulphide body. Commonly these range from 60cm to 120cm in thickness but can obtain widths of 4.5 metres. These are usually discontinuous and uncorrelatable between successive drill holes. The mudstone is composed of 20-30 percent quartz and feldspar grains within a groundmass of chlorite, carbonate, sericite and opaque minerals. The feldspar grains can usually be quite large (2-3mm) and give the unit a porphyritic appearance.

3.5.3 Reserves

To date only estimated geological reserves exist on the main sulphide body at Murray Brook. These have been reported as 23.6 million tons grading 1.95% zinc, 0.86% lead, 0.44% copper and 28.44 g/tonne Ag (Rankin, 1981). No figures concerning gold have been reported. This is due to the fact that limited analytical data for this metal was obtained during exploration (Smith,N., personnal communication, 1990).

NovaGold has stated that gold values have been found in the pyrite zone surrounding the ore body. The inference being that the gold may be tied up within the disseminated pyrite. The limited drilling control on this zone prevents quantification of either its size or grade.

3.6 MIDDLE RIVER PROSPECT

The Middle River prospect, located 20km southeast of Bathurst is accessible via the Road to Resources, the Arseneau Road and various bush roads. Although earlier interest existed in the property, specifically with a transported gossan, current interest stems from 1984, when C. Willett discovered massive sulphide float on the property while prospecting. The property, held jointly by Willett and T. Mersereau (1986a, 1987), was optioned to ESSO Minerals, who in turn farmed it out to Granges Exploration Ltd. Upon dissolution, ESSO sold the property, amongst others, to Homestake Mineral Development Co., who are currently seeking a partner to undertake further exploration (Hoy, D., personnel communication, 1990).

3.6.1 Geology

The property is underlain by metasediments (Os_3) and metabaslts (Omv_2) of the Ordovician Tetagouche group (Figure 3.0.1). The regional geologic trend is generally northeasterly with the rocks exhibiting evidence of polyphase deformation. A major east-northeast trending fault transects the northern part of the property.

3.6.2 Mineralogy

Pyritiferous float bearing arsenopyrite, found on the property, contained between 0.03 and 25.5 g/tonne gold (Mersereau, 1987). Low gold values were obtained from pyritiferous drill core cut by Granges Exploration (O'Donnell, 1987 and 1989) with a recommendation that further drilling be undertaken. Additional drilling was completed (Hoy,D., personnel communication, 1990), although the results are confidential until 1991.

Hoy likens the gold mineralization and its mode of emplacement to that at the Elmtree deposit. This suggests that the gold is expected to be refractory.

3.6.3 Reserves

The exploration work completed to date does not permit quantification of reserves.

4.0 CONCLUSIONS

Six properties out of all the known gold occurrences in the province were identified as having potential for the production of refractory gold ore. Four of these properties, **Elmtree**, **Millstream West**, **Simpson Field**, and **Middle River** are, in terms of their economic potential, monomineralic gold properties. Elmtree is the only one of the four which can be characterized as a gold deposit in that it is the only one containing quantifiable reserves. The remaining two properties, **Caribou** and **Murray Brook**, are massive sulphide deposits bearing gold.

The **Elmtree** deposit contains between 500,000 and 750,000 tonnes of indicated geological reserves grading 4.38 g/tonne gold. These reserves have a moderate degree of geologic assurance of existence. Their calculation was based solely upon geological parameters; no production criteria were used. Metallurgical evaluation of the ore proves that it is refractory in nature.

The discovery of the Elmtree deposit sparked intense exploration activity around Siluro-Devonain mafic intrusives in Northern New Brunswick. Three of the properties listed, **Millstream West**, **Simpson Field** and to some degree **Middle River** are prospects whose development has been dependant on this activity. Available mineralogical data suggests that these three properties are similar to the Elmtree deposit suggesting that their gold content is also refractory. Metallurgical evaluation, however, is necessary in order to determine the nature of the gold associated with these three properties. Exploration results to date do not permit quantification of reserves on the properties, hence their characterization as prospects. On-going exploration activity, however, dictates that the status of these properties is not fixed. As new information becomes available and as exploration continues, it is conceivable that any one or more of the properties could be found to contain a deposit of refractory gold. Similarly, new

discoveries of yet unidentified prospects will likely be made in similar geologic terrains resulting in the identification of new prospects bearing refractory gold.

The massive sulphide deposits at **Murray Brook** and **Caribou** hold promise for providing pre-processed refractory gold-bearing tailings to the appropriate processing facility. The lack of gold assay values for the primary (unoxidized) ore in the **Murray Brook** deposit, however makes discussion of its potential speculative at this time. In addition, indications exist which suggest that a halo of auriferous pyrite may be associated with the deposit. It is expected that this material would be in part at least, refractory. As delineation of the primary ore and the auriferous pyrite halo at the Murray Brook deposit progresses their gold content will be better defined in terms of distribution, grade and mineralogy.

Detailed deposit delineation work and production experience at the **Caribou** deposit provides hard data on the quantitiy of gold associated with the deposit and the quantity of refractory gold which passes through the mill to the tailings. The deposit contains:

	tonnes	Zn (%)	Pb (%)	Ag g/tonne	Au
proven ore	1,882,000	8.29	3.69	101.9	1.6
indicated ore	2,292,000	8.60	3.96	116.0	1.7
inferred ore	7,000,000	12 combined		na	na

na - not available

Approximately 10% (0.16 grams/tonne) of the gold and 38% (67 grams/tonne) of the silver is extracted from the ore, the remainder is disposed of with the tailings. This equates to in excess of 1,000,000 grams of refractory gold and over 45,000,000 grams of silver being disposed of from the Caribou deposit annually.

The custom mill approach for processing refractory gold ores is presently best suited for integration with the Caribou processing facility. However, the size of such a facility would have to be determined. The extraction technology which would be best suited for Caribou tailings would probably be adequate for processing any ore which could be expected to be produced from the Elmtree-type of refractory gold properties. If the primary ore and/or auriferous pyrite at Murray Brook is produced, then a scenario similar to that envisioned for the Caribou tailings is worthy of consideration.

It is known that gold is associated with the lead-zinc ores which make up the deposits in the Bathurst Mining Camp. A portion, at least of this gold is refractory, making these deposits possible sources of refractory gold tailings. Similarily, past producers of lead-zinc concentrates in the Bathurst area yielded tailings which remain accessible. Although the technical and economic feasibility of extracting the refractory gold which may be contained in any of these tailings has yet to be determined, the economics of such a venture could be enhanced through the extraction of additional by-products from the tailings. Such extraction could also aid in alleviating the environmental difficulties currently encountered with tailings disposal. By way of specific example, Brunswick Mining and Smelting accounts for most of the tailings in the Bathurst mining camp, both in terms of inventory and production. Approximately 50 million tonnes of tailings are on-site with an additional 2.7 to 3.0 million tonnes being added annually. The tailings currently being produced contain 0.65 g/tonne gold and 30.0 g/tonne silver resulting in their being worth approximately $47.5 million annually. In addition, during the early years of Brunswick's operation the bulk of the silver reported to the tailings resulting in the original tailings having anomalous silver content.

5.0 RECOMMENDATIONS

1. Based on the status of mineral exploration and the known ore reserves, the custom mill concept is best suited for processing gold and silver-bearing tailings from the Caribou deposit. Ongoing assessment of developments at the other refractory gold-bearing properties identified in the province could lead to supplementary feedstock for the custom mill.

2. Delineation of the various refractory gold-bearing properties must be advanced to a stage where quantification of reserves would permit evaluation of their ability to supply ore to a refractory gold processing facility. In addition, laboratory assessment of the refractory nature of the ores from the various properties identified is required. This assessment should include bench scale cyanidation tests.

3. Evaluation of the technical and economic feasibility of extracting the refractory gold which may be contained in the inventory of mine tailings found in the Bathurst mining camp is warranted. This inventory of mine tailings is spread amongst several past and current producers of base metals in the camp. The economics of such a venture could be enhanced by the extraction of additional by-products from the tailings which could also mitigate environmental difficulties currently encountered with tailings disposal.

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7.0 GLOSSARY

anhedral: Said of a mineral crystal that has failed to develop its own rational faces or that has a rounded or indeterminate form produced by crowding of adjacent mineral grains during crystallization or re-crystallization.

anorthosite: A group of essentially monomineralic plutonic igneous rocks composed almost entirely of plagioclase feldspar and little or no dark-coloured minerals.

argillaceous: Pertaining to, largely composed of, or containing clay-size particles or clay minerals.

carbonatization: Introduction of, or replacement by carbonates.

chert: A hard, compact, dull to semivitreous, microcrystalline or cryptocrystalline sedimentary rock, consisting dominantly of interlocking crystals of quartz.

diabase: An intrusive rock whose main components are labradorite (plagioclase) and pyroxene and which is characterized by ophitic texture (lath-shape plagioclase crystals partially or completely included in pyroxene crystals).

epigenetic: Said of a mineral deposit of origin later than that of the enclosing rocks.

euhedral: Said of a mineral grain that is completely bounded by its own rational faces and whose growth during crystallization or re-crystallization was not restrained or interfered with by adjacent grains.

felsite: A general term for any light-coloured, fine-grained or aphanitic extrusive igneous rock composed chiefly of quartz and feldspar.

gabbro: A group of dark-coloured, basic intrusive igneous rocks composed principally of basic plagioclase and clinopyroxene, with or without olivine and orthopyroxene. The approximate intensive equivalent of basalt.

gangue: The valueless rock or mineral aggregates in an ore.

hornfels:	A fine-grained rock composed of a mosaic of equidimensional grains without preferred orientation and typically formed by contact metamorphism.
illite:	A general name for a group of three-layer mica-like clay minerals.
porphyry:	An igneous rock of any composition that contains conspicuous phenocrysts in a fine-grained groundmass.
sericitization:	The hydrothermal, deuteric or metamorphic processes involving the introduction of, alteration to, or replacement by sericitic muscovite.
silicification:	The introduction of, or replacement by silica.
sill:	A tabular igneous intrusion that parallels the planar structure of the surrounding rock.
skarn:	Sulphide-bearing lime-silicates derived from nearly pure limestone and dolomite.
specularite:	A black or grey variety of hematite with a metallic lustre. It occurs in micaceaous or foliated masses, or in tabular or disklike crystalls.
subhedral:	Said of a mineral grain that is bounded partly by its own rational faces and partly by surfaces formed against pre-existing grains as a result of either crystallization or re-crystallization.
supergene:	Said of a mineral deposit or enrichment formed near the surface.
synform:	A fold whose limbs close downward in strata for which the stratigraphic sequence is unknown.
tuffaceous:	Said of sediments containing up to 50% tuff, a consolidated pyroclastic rock.